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CE notification

The PCI-1784, developed by ADVANTECH CO., LTD., has passed the CE test for environmental specifications when shielded cables are used for external wiring. We recommend the use of shielded cables. This kind of cable is available from Advantech. Please contact your local supplier for ordering information.

On-line Technical Support

For technical support and service, please visit our support website at:
http://www.advantech.com/support

Note:

✎ Concerning the environment protection, we'd like to reduce the paper using for the user's manual. Starting the page of *Appendix C*, please find the PDF file of the CD-ROM.

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1. Introduction

Thank you for buying the Advantech PCI-1784. The PCI-1784 is a 4-axis quadrature encoder and counter card for PCI bus. This card includes four 32-bit quadruple AB phase encoder counters, 8-bit timer with multi range time-base selector and four isolated digital input and four isolated digital output. Its flexible interrupt sources are suitable for motor control and position monitoring.

The following sections of this chapter will provide further information about features of the multifunction cards, a Quick Start for installation, together with some brief information on software and accessories for the PCI-1784 card.

1.1 Features

- ❑ Four 32-bit up/down counters
- ❑ Single ended or differential inputs
- ❑ Pulse/direction and up/down counter
- ❑ x1, x2, x4 counts for each encoder cycle
- ❑ Optically isolated up to 2500 V_{DC}
- ❑ 4-stage digital filter with selectable sampling rate
- ❑ On board 8-bit timer with wide range time-base selector
- ❑ Multiple interrupt sources for precision application
- ❑ Four isolated digital input
- ❑ Four isolated digital output with flexible function
- ❑ Board ID

The Advantech PCI-1784 offers the following main features:

Encoder Interface

Each channel includes a decoding circuit for incremental quadrature encoding. Inputs accept either single-ended or differential signals. Quadrature input works with or without an index, allowing linear or rotary encoder feedback.

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Counters

The PCI-1784 has four independent 32-bit counters. The maximum quadrature input rate is 2 MHz, and the maximum input rate in counter mode is 8 MHz. You can individually configure each counter for quadrature decoding, pulse/direction counting or up/down counting.

Digital Input and Interrupts

The PCI-1784 provides four digital input channels. Each channel accepts digital input as an index input for a rotary encoder or as a home sensor input for a linear encoder. The card can generate an interrupt to the system based on a signal from its digital inputs, overflow/underflow and over-compare/under-compare of its counters, or on a programmed time interval. It can repeatedly generate interrupts at any time interval you specify, from 20 micro second to 51 second. These interrupts let you precisely monitor the speed of a control system.

Flexible Digital Output function

The PCI-1784 provides four digital output channels. Each channel accepts digital output as a normal TTL output for a rotary encoder, or as an indicated output with pulse/level mode for a linear encoder. The PCI-1784 can generate an indicated output based on a signal from over-compare/under-compare of its counters. The pulse width of an indicated output is depends on the counter clock or clear interrupt.

Special Shielded Cable for Noise Reduction

The PCL-10137H shielded cable is specially designed for the PCI-1784 for reducing noise. Its wires are all twisted pairs, and the input signals and output signals are separately shielded, providing minimal cross talk between signals and the best protection against EMI/EMC problems.

Keeping the Counter Values and the Output Status after system reset

Users can independently use the four counter channels. When the system is hot reset (power not shut down), the PCI-1784 can either retain the last counter values and the output status, or return to its

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default configuration, depending on jumper setting. This practical function eliminates danger caused by miss-operation during unexpected system reset.

Board ID

The PCI-1784 has a built-in DIP Switch that helps define each card's ID when multiple PCI-1784 cards have been installed on the same PC chassis. The board ID setting function is very useful when users build their system with multiple PCI-1784 cards. With correct Board ID settings, you can easily identify and access each card during hardware configuration and software programming.

Note:

✎ For detailed specifications of the PCI-1784, please refer to *Appendix A, Specifications.*

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1.2 Applications

- ❑ Motion control
- ❑ Position sensing, monitoring and measuring
- ❑ Coordinate measuring machines
- ❑ X-Y table monitors
- ❑ Robotics
- ❑ Machine control

1.3 Installation Guide

Before you install your PCI-1784 card, please make sure you have the following necessary components:

- ❑ **PCI-1784 DA&C card**
- ❑ **PCI-1784 User's Manual**
- ❑ **Driver software** Advantech DLL drivers (included in the companion CD-ROM)
- ❑ **Wiring cable** PCL-10137H (option)
- ❑ **Wiring board** ADAM-3937 (option)
- ❑ **Computer** Personal computer or workstation with a PCI-bus slot (running Windows 2000/95/98/ NT/ME/XP)

Some other optional components are also available for enhanced operation:

- ❑ **Application software** ActiveDAQ, GeniDAQ or other third-party software packages

After you get the necessary components and maybe some of the accessories for enhanced operation of your Multifunction card, you can then begin the Installation procedures. Figure 1-1 on the next page provides a concise flow chart to give users a broad picture of the software and hardware installation procedures:

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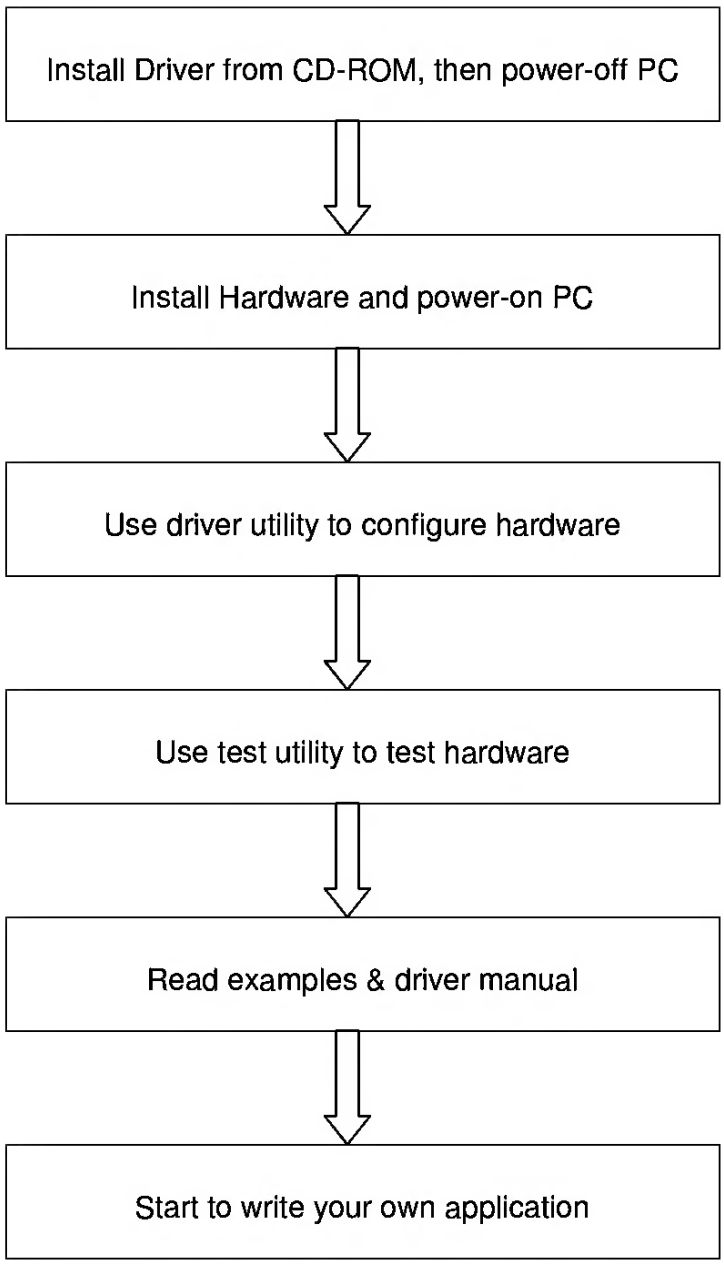
Install Driver from CD-ROM, then power-off PC
Install Hardware and power-on PC
Use driver utility to configure hardware
Use test utility to test hardware
Read examples & driver manual
Start to write your own application

Fig. 1-1 Installation Flow Chart

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1.4 Software Overview

Advantech offers a rich set of DLL drivers, third-party driver support and application software to help fully exploit the functions of your PCI-1784 card:

- Device Drivers (on the companion CD-ROM)
- LabVIEW driver*
- Advantech ActiveDAQ
- Advantech GeniDAQ

Programming choices for DA&C cards: You may use Advantech application software such as Advantech Device Drivers. On the other hand, advanced users are allowed another option for register-level programming, although not recommended due to its laborious and time-consuming nature.

Device Drivers

The Advantech Device Drivers software is included on the companion CD-ROM at no extra charge. It also comes with all the Advantech DA&C cards. Advantech's device drivers features a complete I/O function library to help boost your application performance. The Advantech Device Drivers for Windows 2000/95/98/ ME/NT/XP works seamlessly with development tools such as Visual C++, Visual Basic, Inprise C++ Builder and Inprise Delphi.

Register-level Programming

Register-level programming is reserved for experienced programmers who find it necessary to write codes directly at the level of device registers. Since register-level programming requires much effort and time, we recommend that you use the Advantech Device Drivers instead. However, if register-level programming is indispensable, you should refer to the relevant information in *Appendix C, Register Structure and Format*, or to the example codes included on the companion CD-ROM.

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1.5 Device Drivers Programming Roadmap

This section will provide you a roadmap to demonstrate how to build an application from scratch using Advantech Device Drivers with your favorite development tools such as Visual C++, Visual Basic, Delphi and C++ Builder. The step-by-step instructions on how to build your own applications using each development tool will be given in the *Device Drivers Manual*. Moreover, a rich set of example source codes are also given for your reference.

Programming Tools

Programmers can develop application programs with their favorite development tools:

- **Visual C++**
- **Visual Basic**
- **Delphi**
- **C++ Builder**

For instructions on how to begin programming works in each development tool, Advantech offers a *Tutorial* Chapter in the *Device Drivers Manual* for your reference. Please refer to the corresponding sections in this chapter on the *Device Drivers Manual* to begin your programming efforts. You can also take a look at the example source codes provided for each programming tool, since they can get you very well-oriented.

The *Device Drivers Manual* can be found on the companion CD-ROM. Or if you have already installed the Device Drivers on your system, The *Device Drivers Manual* can be readily accessed through the ***Start*** button:

Start/Programs/Advantech Driver V2.0/Device Driver Manual

The example source codes could be found under the corresponding installation folder such as the default installation path:
\Program Files\Advantech\ADSAPI\Examples

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For information about using other function groups or other development tools, please refer to the *Creating Windows 95/NT/2000 Application with Device Drivers* chapter and the *Function Overview* chapter on the *Device Drivers Manual.*

Programming with Device Drivers Function Library

Advantech Device Drivers offers a rich function library to be utilized in various application programs. This function library consists of numerous APIs that support many development tools, such as Visual C++, Visual Basic, Delphi and C++ Builder.

According to their specific functions or services, those APIs can be categorized into several function groups:

- **Digital Input/Output Function Group**
- **Counter Function Group**
- **Port Function Group (direct I/O)**
- **Event Function Group**

For the usage and parameters of each function, please refer to the *Function Overview* chapter in the *Device Drivers Manual.*

Troubleshooting Device Drivers Error

Driver functions will return a status code when they are called to perform a certain task for the application. When a function returns a code that is not zero, it means the function has failed to perform its designated function. To troubleshoot the Device Drivers error, you can pass the error code to **DRV_GetErrorMessage** function to return the error message. Or you can refer to the *Device Drivers Error Codes* Appendix in the *Device Drivers Manaul* for a detailed listing of the Error Code, Error ID and the Error Message.

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1.6 Accessories

Advantech offers a complete set of accessory products to support the PCI-1784 card. These accessories include:

Wiring Cable

❑ **PCL-10137H** The PCL-10137H shielded cable is specially designed for PCI-1784 cards to provide high resistance to noise. To achieve a better signal quality, the signal wires are twisted in such a way as to form a "twisted-pair cable", reducing cross-talk and noise from other signal sources. Furthermore, its analog and digital lines are separately sheathed and shielded to neutralize EMI/EMC problems.

Wiring Boards

❑ **ADAM-3937** The ADAM-3937 is a 37-pin D-type wiring terminal module for DIN-rail mounting. This terminal module can be readily connected to the Advantech PC-Lab cards and allow easy yet reliable access to individual pin connections for the PCI-1784 card.

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2. Installation

This chapter gives users a package item checklist, proper instructions about unpacking and step-by-step procedures for both driver and card installation.

2.1 Unpacking

After receiving your PCI-1784 package, please inspect its contents first. The package should contain the following items:

☑ PCI-1784 card
☑ Companion CD-ROM (DLL driver included)
☑ User's Manual

The PCI-1784 card harbors certain electronic components vulnerable to *electrostatic discharge* (ESD). ESD could easily damage the integrated circuits and certain components if preventive measures are not carefully paid attention to.

Before removing the card from the antistatic plastic bag, you should take following precautions to ward off possible ESD damage:

- Touch the metal part of your computer chassis with your hand to discharge static electricity accumulated on your body. Or one can also use a grounding strap.
- Touch the anti-static bag to a metal part of your computer chassis before opening the bag.
- Take hold of the card only by the metal bracket when removing it out of the bag.

After taking out the card, first you should:

- Inspect the card for any possible signs of external damage (loose or damaged components, etc.). If the card is visibly damaged, please notify our service department or our local sales representative immediately. Avoid installing a damaged card into your system.

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Also pay extra caution to the following aspects to ensure proper installation:

- Avoid physical contact with materials that could hold static electricity such as plastic, vinyl and Styrofoam.
- Whenever you handle the card, grasp it only by its edges. DO NOT TOUCH the exposed metal pins of the connector or the electronic components.

Note:

✎ Keep the anti-static bag for future use. You might need the original bag to store the card if you have to remove the card from PC or transport it elsewhere.

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2.2 Driver Installation

We recommend you to install the driver before you install the PCI-1784 card into your system, since this will guarantee a smooth installation process.

The Advantech Device Drivers Setup program for the PCI-1784 card is included on the companion CD-ROM that is shipped with your DA&C card package. Please follow the steps below to install the driver software:

Step 1: Insert the companion CD-ROM into your CD-ROM drive.

Step 2: The Setup program will be launched automatically if you have the autoplay function enabled on your system. When the Setup Program is launched, you'll see the following Setup Screen.

Note:

✎ If the autoplay function is not enabled on your computer, use Windows Explorer or Windows ***Run*** command to execute SETUP.EXE on the companion CD-ROM.

Fig. 2-1 The Setup Screen of Advantech Automation Software

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Step 3: Select the *Individual Drivers* option.

Step 4: Select the specific device then just follow the installation instructions step by step to complete your device driver setup.

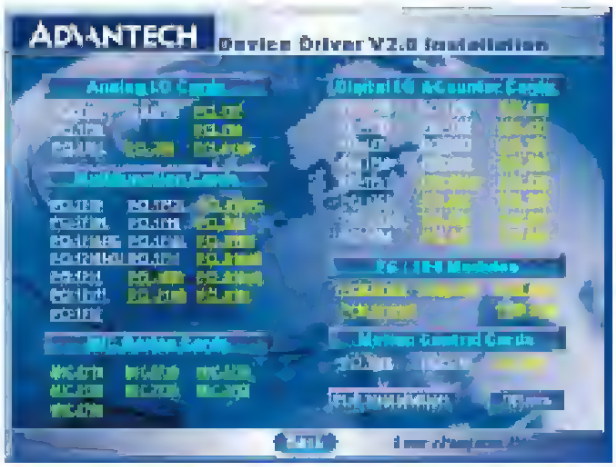

Fig. 2-2 Different options for Driver Setup

For further information on driver-related issues, an online version of *Device Drivers Manual* is available by accessing the following path:

Start/Programs/Advantech Device Drivers V2.0/Device Driver Manual

2.3 Hardware Installation

Note:

✎ Make sure you have installed the driver first before you install the card (please refer to *2.2 Driver Installation*)

After the DLL driver installation is completed, you can now go on to install the PCI-1784 card in any PCI slot on your computer. But it is suggested that you should refer to the computer user manual or related documentation if you have any doubt. Please follow the steps below to install the card on your system.

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Step 1: Turn off your computer and unplug the power cord and cables. TURN OFF your computer before installing or removing any components on the computer.

Step 2: Remove the cover of your computer.

Step 3: Remove the slot cover on the back panel of your computer.

Step 4: Touch the metal part on the surface of your computer to neutralize the static electricity that might be on your body.

Step 5: Insert the PCI-1784 card into a PCI slot. Hold the card only by its edges and carefully align it with the slot. Insert the card firmly into place. Use of excessive force must be avoided, otherwise the card might be damaged.

Step 6: Fasten the bracket of the PCI card on the back panel rail of the computer with screws.

Step 7: Connect appropriate accessories (37-pin cable, wiring terminals, etc. if necessary) to the PCI card.

Step 8: Replace the cover of your computer chassis. Re-connect the cables you removed in step 2.

Step 9: Plug in the power cord and turn on the computer.

Note:

✎ In case you installed the card without installing the DLL driver first, Windows 95/98/ME will recognize your card as an "unknown device" after rebooting, and will prompt you to provide the necessary driver. You should ignore the prompting messages (just click the ***Cancel*** button) and set up the driver according to the steps described in *2.2 Driver Installation*.

After the PCI-1784 card is installed, you can verify whether it is properly installed on your system in the *Device Manager*:

1. Access the *Device Manager* through *Control Panel/System/Device Manager*.
2. The *device name* of the PCI-1784 should be listed on the *Device Manager* tab on the System *Property* Page.

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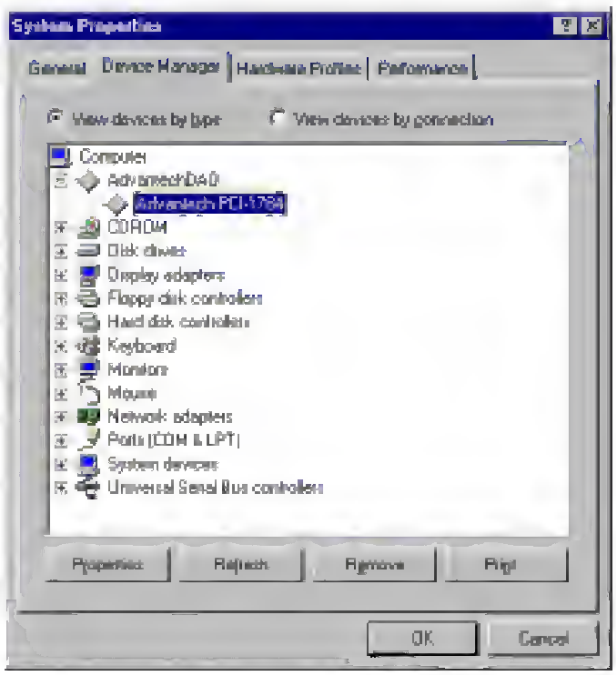

Fig. 2-3 The device name listed on the Device Manager

Note:

✎ If your card is properly installed, you should see the *device name* of your card listed on the *Device Manager* tab. **If you do see your device name listed on it but marked with an exclamation sign "!", it means your card has not been correctly installed.** In this case, remove the card device from the *Device Manager* by selecting its device name and press the ***Remove*** button. Then go through the driver installation process again.

After your card is properly installed on your system, you can now configure your device using the *PCI-1784 Utility* program that has itself already been installed on your system during driver setup. A complete device installation procedure should include *board selection* and *device setup*. After that, you can operate this card through the *operation*. The following sections will guide you through the *board selection*, *device setup* and *operation* of your device.

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2.4 Device Setup & Configuration

The *PCI-1784 Utility* program is a utility that allows you to setup, configure and test your device, and later stores your settings on the system registry. These settings will be used when you call the APIs of Advantech Device Drivers.

Board selection

After your card is properly inserted, the Windows system will install the drivers properly. You just need to launch the *PCI-1784 Utility* for board selection. Click ***Board Selection*** and the *board dialog* box will appear as seen below (Fig. 2-4):

Fig. 2-4 The 'Board Selection' dialog box

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Setting Up and configure the device

Click ***Setup*** to configure each parameter. The dialog box will appear as seen below (Fig. 2-5):

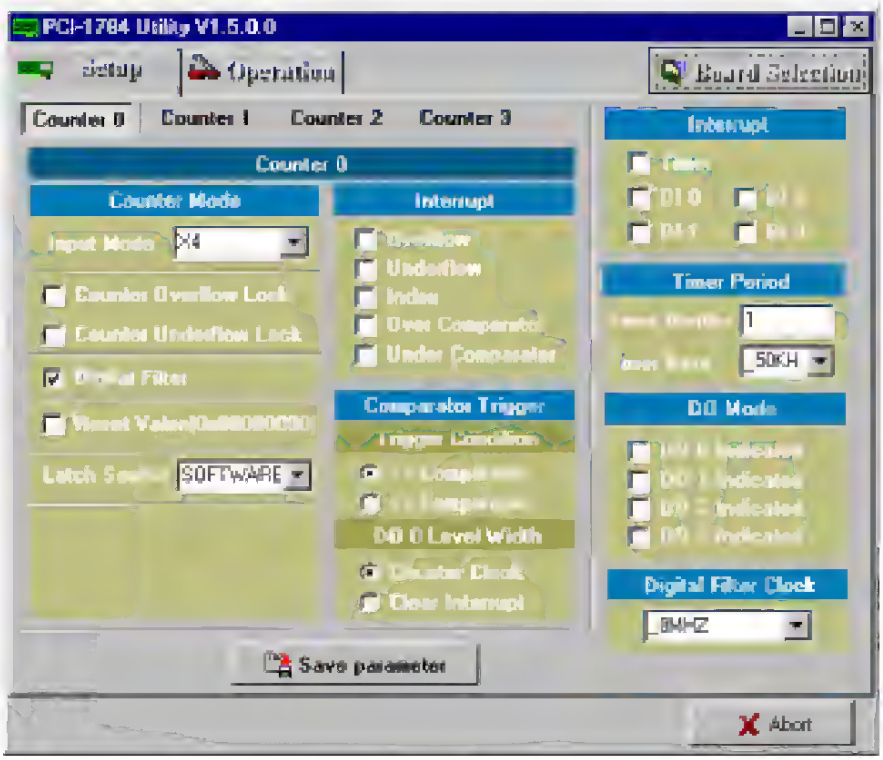

Fig. 2-5 The 'Setup' dialog box

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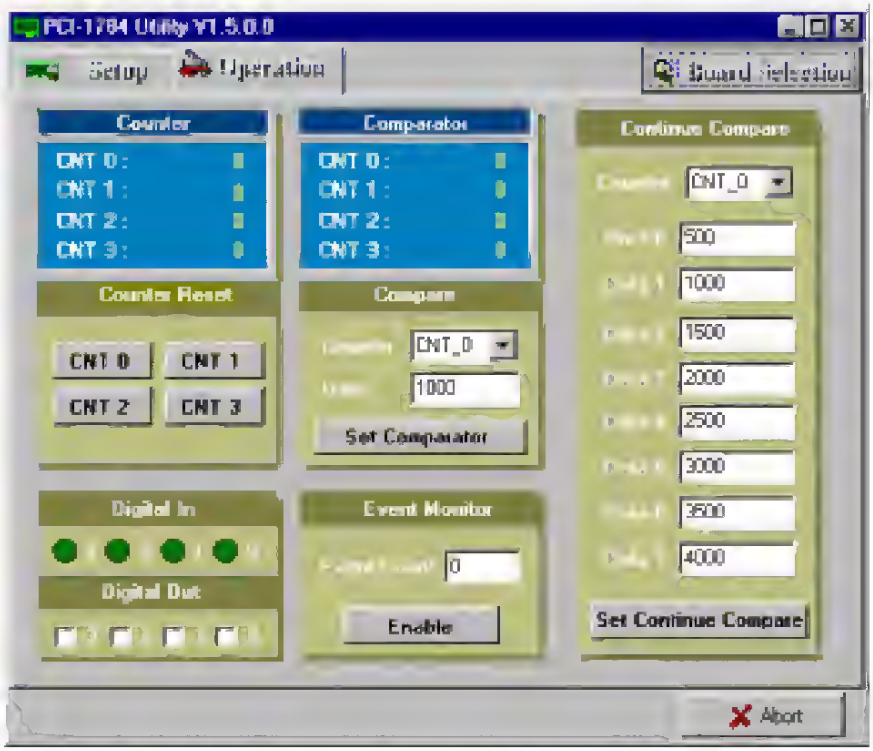

Fig. 2-6 The "Operation" dialog box

After your card is properly installed and configured, you can click the ***Operation*** button to test your hardware. For more detailed information, please refer to *Chapter 2* of the *Device Drivers Manual*.

You can also find the rich examples on the CD-ROM to speeding up your programming.

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3. Signal Connections

3.1 Overview

Maintaining signal connections is one of the most important factors in ensuring that your application system is sending and receiving data correctly. A good signal connection can avoid unnecessary and costly damage to your PC and other hardware devices. This chapter provides useful information about how to connect input and output signals to the PCI-1784 via the I/O connector.

3.2 Switch and Jumper Settings

The PCI-1784 card has one function switch and five jumper settings.

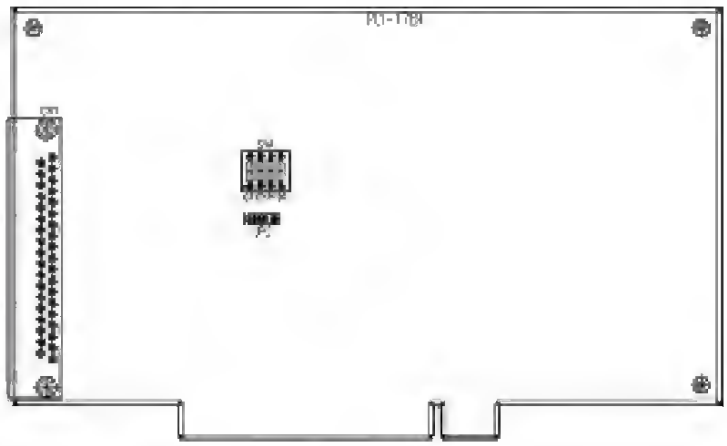

Fig. 3-1 Card connector, jumper and switch locations

Table 3-1: Summary of jumper settings

Names of Jumpers	Function description	
JP2		Keep last status after hot reset
		Default configuration

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Setting the time to reset the digital outputs and the counter value

Some users will want the capability of clearing each counter and the isolated digital output when the system (or PC) issues a reset signal on the PCI bus. Some users will want to clear their counter and digital output only as part of system power-on.

The PCI-1784 satisfies both these needs by providing jumper JP2. Depending on the application, this capability may allow counter value and the isolated digital outputs to be "OFF" without requiring a complete shutdown of processes controlled by the card.

Complete loss of power to the chip clears the chip memory. Thus, no matter how JP2 is set, if the power to the PCI-1784 is disconnected, the counter value and the isolated digital output initial power-on state will be "OFF".

Board ID setting (SW1)

ID3	ID2	ID1	ID0	Board ID
1	1	1	1	0
1	1	1	0	1
1	1	0	1	2
1	1	0	0	3
1	0	1	1	4
1	0	1	0	5
1	0	0	1	6
1	0	0	0	7
0	1	1	1	8
0	1	1	0	9
0	1	0	1	10
0	1	0	0	11
0	0	1	1	12
0	0	1	0	13
0	0	0	1	14
0	0	0	0	15

Note: On: 1, Off: 0

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3.3 Signal Connections

Pin Assignment

Figure 3-2 shows the pin assignments for the 37-pin I/O connector on the PCI-1784.

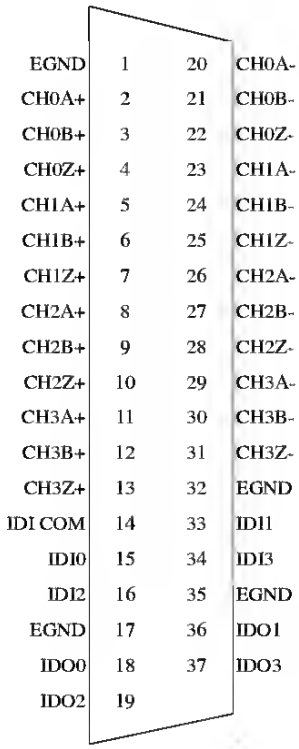

Fig. 3-2 I/O connector pin assignments for the PCI-1784

I/O Connector Signal Description

Table 3-2 I/O Connector Signal Description

Signal Name	Reference	Direction	Description
EGND	-	-	**External Ground.**
CH<0..3>A+	EGND	Input	**Channel <0..3> A differential positive-input.**
CH<0..3>A-	EGND	Input	**Channel <0..3> A differential negative-input.**
CH<0..3>B+	EGND	Input	**Channel <0..3> B differential positive-input.**
CH<0..3>B-	EGND	Input	**Channel <0..3> B differential negative-input.**
CH<0..3>Z+	EGND	Input	**Channel <0..3> Z differential positive-input.**
CH<0..3>Z-	EGND	Input	**Channel <0..3> Z differential negative-input.**
IDI<0..3>	IDI COM	Input	**Isolated Digital Input, Channels 0 through 3.**
IDI COM	-	-	**Common input of the Isolated Digital Input.**
IDO<0..3>	EGND	Output	**Isolated Digital Output, Channels 0 through 3.**
EGND	-	-	**External Ground.**

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Quadrature encoder input

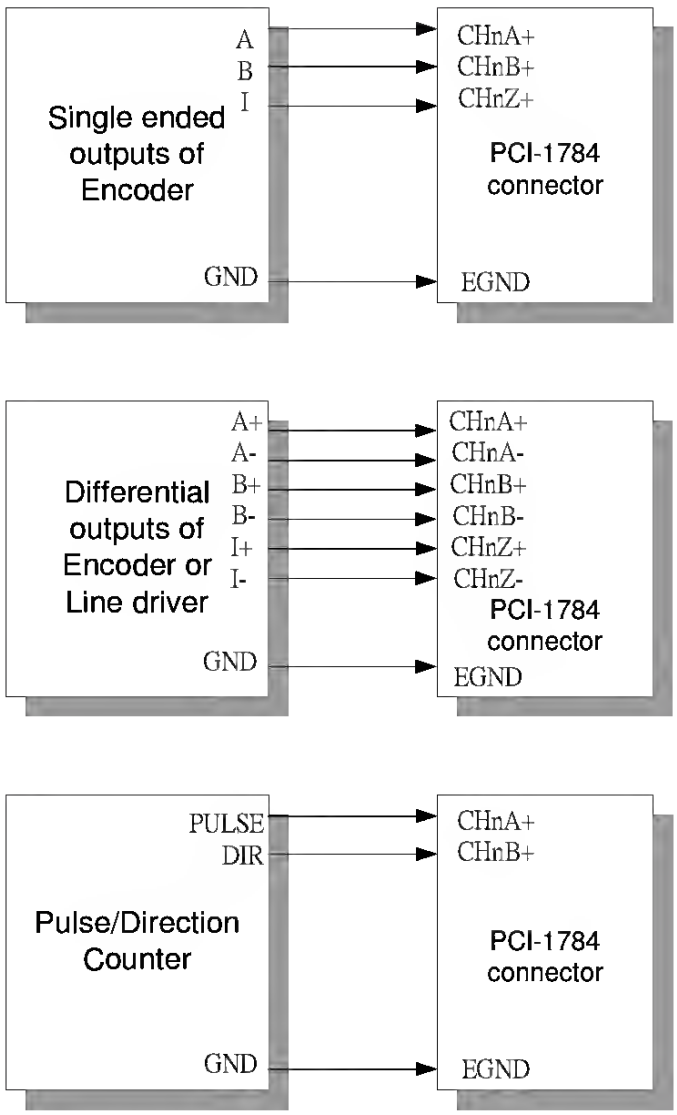

Figure 3-3: Quadrature encoder input connections

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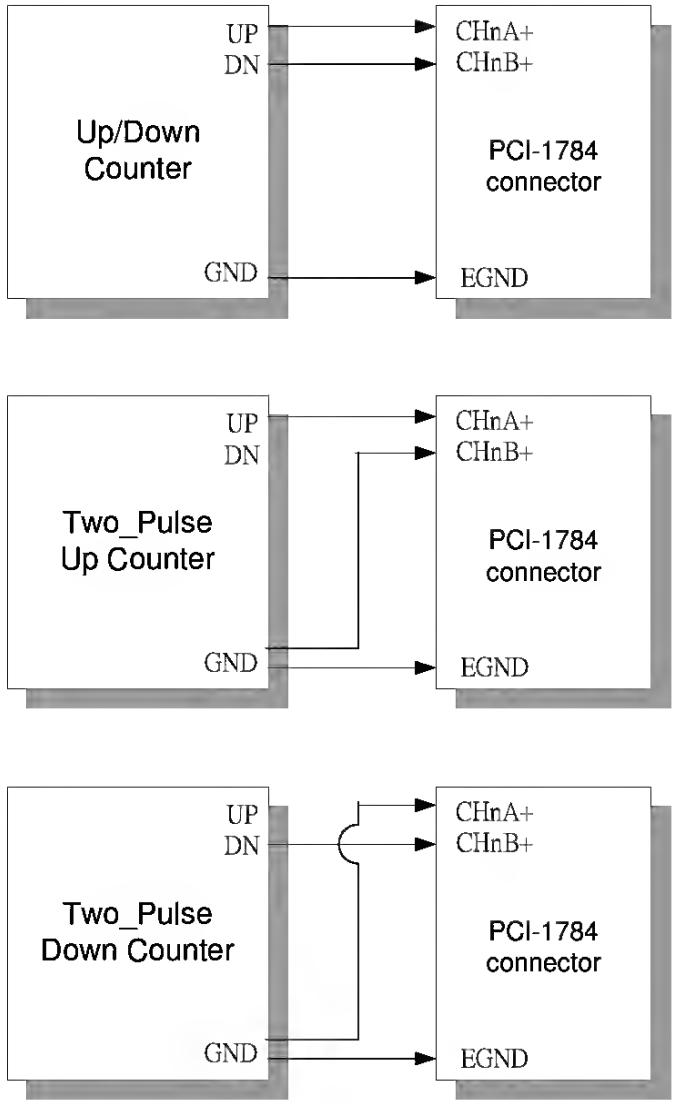

Figure 3-4: Quadrature encoder (up/down counter) input connections

---

Note:

✎ In case you want to connect the Up/Down counter signal into the PCI-1784, be sure that all the signals must be connected. The floating connection will cause unexpected result.

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Isolated digital input

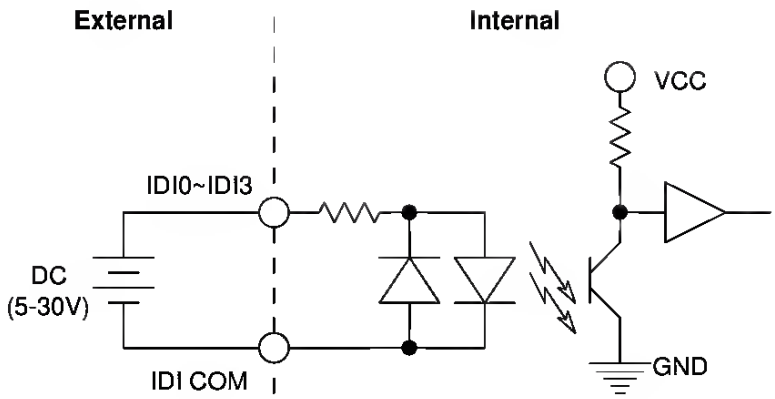

Figure 3-4: Isolated digital input connections

Isolated digital output

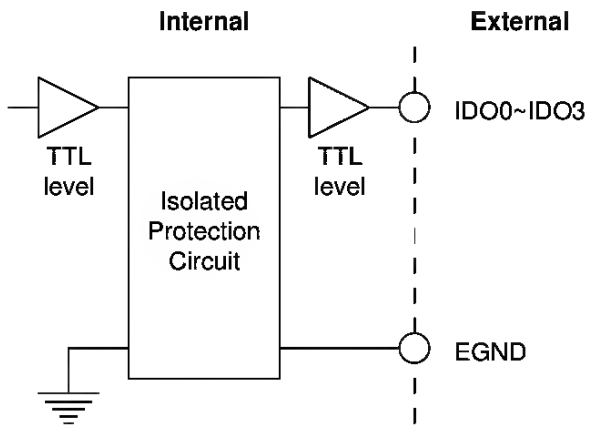

Figure 3-5: Isolated digital output connections

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Appendix A. Specifications

Encoder Output

Number of Axis	4 (independent)	
Resolution	32-bit	
Max. Quadrature Input Frequency	w/ Digital Filter	1.0 MHz
	w/o Digital Filter	2.0 MHz
Digital Filter	4 stage	
Drive Type	Single-ended or differential	
Counter Mode	Quadrature, Up/Down, Count/Direction	
Optical Isolation	2500 V_{DC}	
Max. Input Pulse Frequency	x 1, x 2, x 4	
Sample Clock Frequency	8, 4, 2, or 1 MHz	

Timer

Resolution	8-bit
Time base	50 K, 5 K, 500, 50, 5 Hz

Isolated Digital Input

Number of Channel	4	
Optical Isolation	2500 V_{DC}	
Opto-isolator response time	25μs	
Over-voltage Protect	70 V_{DC}	
Input Voltage	VIH (max.)	30 V_{DC}
	VIH (min.)	10 V_{DC}
	VIL (max.)	3 V_{DC}
Input Current	10 V_{DC}	1.7 mA (typical)
	12 V_{DC}	2.1 mA (typical)
	24 V_{DC}	4.4 mA (typical)

Isolated Digital Output

Number of Channel	4
Optical Isolation	2500 V_{DC}
Response time	20 μs (max.)
Supply Voltage	TTL level
Sink/Source Current	50 mA max./channel

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Interrupt

Source	Counter overflow, Counter underflow, Index input, Compare, Timer, Digital input

Counter Latch

Source	Software, Timer, Index input, Digital input

General

I/O Connector Type	37-pin D-sub female	
Dimensions	175 mm x 100 mm (6.9" x 3.9")	
Power Consumption	Typical	+5 V @ 200 mA
	Max.	+5 V @ 450 mA
Temperature	Operation	0~60°C (32~140°F) (refer to IEC 68-2-1,2)
	Storage	-20~70°C (-4~158°F)
Relative Humidity	5~95%RH non-condensing (refer to IEC 68-2-3)	
Certification	CE certified	

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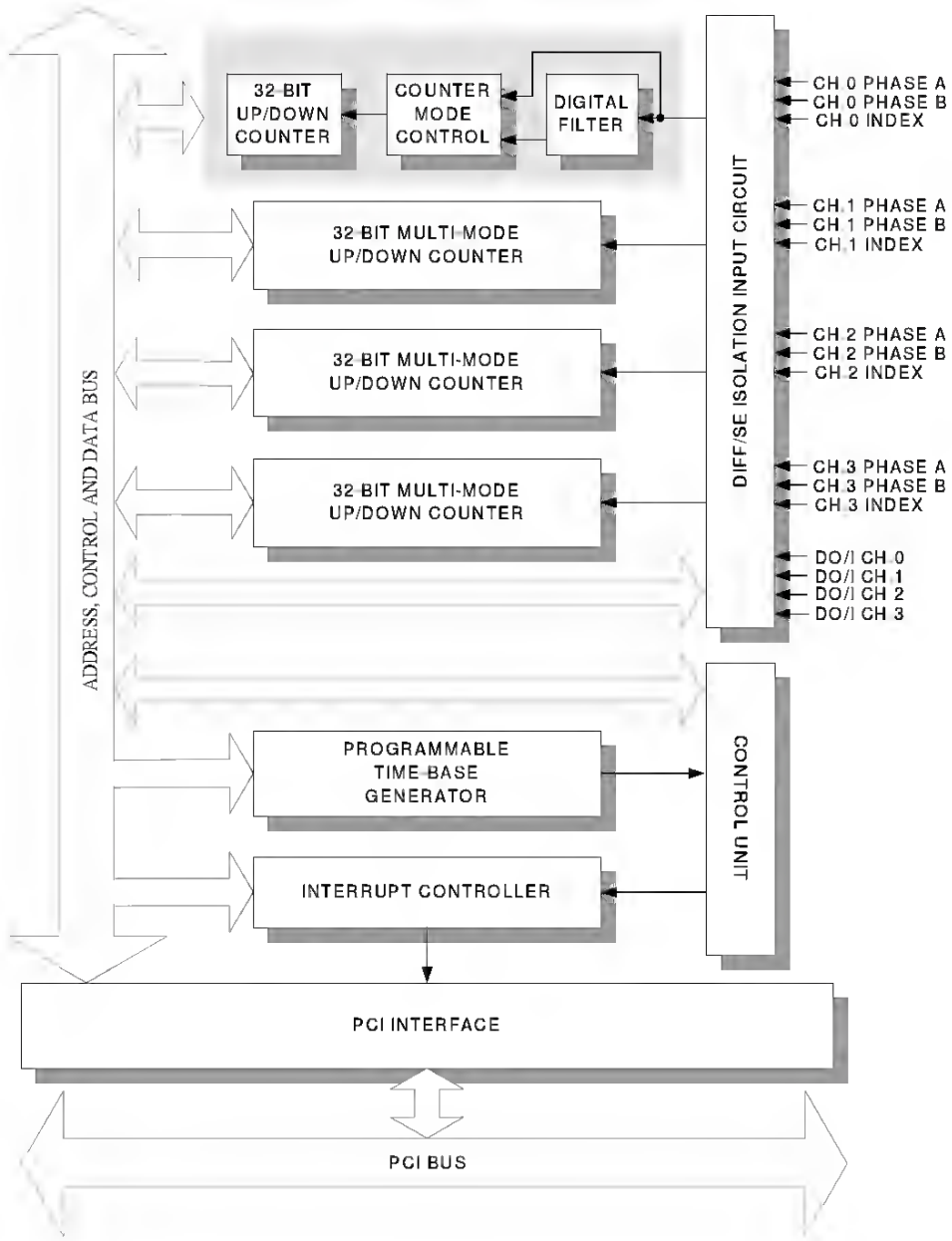
Appendix B. Block Diagram



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Appendix C. Register Structure and Format

C.1 Overview

The PCI-1784 is delivered with an easy-to-use 32-bit DLL driver for user programming under the Windows 2000/95/98/NT/ME/XP operating system. We advise users to program the PCI-1784 using the 32-bit DLL driver provided by Advantech to avoid the complexity of low-level programming by register.

The most important consideration in programming the PCI-1784 the register level is to understand the function of the card's registers. The information in the following sections is provided only for users who would like to do their own low-level programming.

C.2 I/O Port Address Map

The PCI-1784 requires 32 consecutive addresses in the PC's I/O space. The address of each register is specified as an offset from the card's base address. For example, BASE+0 is the card's base address and BASE+6 is the base address plus six bytes.

The table C-1 shows the function of each register of the PCI-1784 or driver and its address relative to the card's base address.

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Table C-1 PCI-1784 register format (Part 1)

Base Address + HEX		PCI-1784 Register Format															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
00H	W	**Counter 0 Mode**															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
	R	**Counter 0 Latch Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
04H	W	**Counter 1 Mode**															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
	R	**Counter 1 Latch Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
08H	W	**Counter 2 Mode**															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
	R	**Counter 2 Latch Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
0CH	W	**Counter 3 Mode**															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
	R	**Counter 3 Latch Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16

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Table C-1 PCI-1784 register format (Part 2)

Base Address + HEX		PCI-1784 Register Format															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
10H	W	**Counter 0 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	**Counter 0 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
14H	W	**Counter 1 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	**Counter 1 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
18H	W	**Counter 2 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	**Counter 2 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
1CH	W	**Counter 3 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	**Counter 3 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16

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Table C-1 PCI-1784 register format (Part 3)

Base Address + HEX		PCI-1784 Register Format															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
20H	W	**Interrupt Control**															
		DI3	DI2	DI1	DI0	IX3	IX2	IX1	IX0	UN3	UN2	UN1	UN0	OV3	OV2	OV1	OV0
		IE			TM					UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0
	R	**Interrupt Status**															
		DI3	DI2	DI1	DI0	IX3	IX2	IX1	IX0	UN3	UN2	UN1	UN0	OV3	OV2	OV1	OV0
		IF			TM					UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0
24H	W	**Clock Control**															
																SC1	SC0
							TB2	TB1	TB0	DV7	DV6	DV5	DV4	DV3	DV2	DV1	DV0
	R	**Clear Interrupt**															
28H	W	**Software Latch**															
														SL3	SL2	SL1	SL0
	R	**Board ID**															
														BD3	BD2	BD1	BD0
2CH	W	**Reset Counter**															
														SR3	SR2	SR1	SR0
	R	**N/A**															
30H	W	**Digital Output**															
														DO3	DO2	DO1	DO0
		DM3	DM2	DM1	DM0	LE3	LE2	LE1	LE0	UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0
	R	**Digital Input/Output**															
										DI3	DI2	DI1	DI0	DO3	DO2	DO1	DO0
		DM3	DM2	DM1	DM0	LE3	LE2	LE1	LE0	UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0

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C.3 Counter 0/1/2/3 mode — BASE+00/04/08/0CH

Table C-2 PCI-1784 Register for counter 0/1/2/3 mode

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
00H	W	**Counter 0 Mode**															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
04H	W	**Counter 1 Mode**															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
08H	W	**Counter 2 Mode**															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0
0CH	W	**Counter 3 Mode**															
		DI3	DI2	DI1	DI0		TM	IX	SW	DF	UL	OL	RF		M2	M1	M0

M2 ~ M0 **Counter input mode control**

000	Disable
001	Quadrature input x 1
010	Quadrature input x 2
011	Quadrature input x 4
100	2 pulse input
101	1 pulse input
110	N/A
111	N/A

RF **Set counter reset value**

0	80000000h
1	00000000h

OL **Counter overflow lock control**

0	Counter continues counting (wraps over) when counter overflow
1	Counter locked when counter overflow

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UL	**Counter underflow lock control**	
	0	Counter continues counting (wraps over) when counter underflow
	1	Counter locked when counter underflow
DF	**Digital Filter**	
	0	Quadrature input frequency without digital filter
	1	Quadrature input frequency with digital filter
SW	**Software latch counter data**	
	0	Disable software latch
	1	Enable software latch
IX	**Index latch counter data**	
	0	Disable index latch
	1	Enable index latch
TM	**Timer latch counter data**	
	0	Disable timer latch
	1	Enable timer latch
DI0	**DI0 latch counter data**	
	0	Disable DI0 latch
	1	Enable DI0 latch
DI1	**DI1 latch counter data**	
	0	Disable DI1 latch
	1	Enable DI1 latch
DI2	**DI2 latch counter data**	
	0	Disable DI2 latch
	1	Enable DI2 latch
DI3	**DI3 latch counter data**	
	0	Disable DI3 latch
	1	Enable DI3 latch

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C.4 Counter 0/1/2/3 latch data — BASE+00/04/08/0CH

Table C-3 PCI-1784 Register for counter 0/1/2/3 latch data

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
00H	R	**Counter 0 Latch Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
04H	R	**Counter 1 Latch Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
08H	R	**Counter 2 Latch Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
0CH	R	**Counter 3 Latch Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16

D31 ~ D0 **Counter latch data**

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C.5 Counter 0/1/2/3 compare data — BASE+10/14/18/1CH

Table C-4 PCI-1784 Register for counter 0/1/2/3 compare data

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
10H	W	**Counter 0 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	**Counter 0 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
14H	W	**Counter 1 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	**Counter 1 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
18H	W	**Counter 2 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	**Counter 2 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
1CH	W	**Counter 3 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16
	R	**Counter 3 Compare Data**															
		D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
		D31	D30	D29	D28	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16

D31 ~ D0 **Counter compare data**

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C.6 Interrupt control register — BASE+20H

Table C-5 PCI-1784 Register for interrupt control

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
20H	W	Interrupt control															
		DI3	DI2	DI1	DI0	IX3	IX2	IX1	IX0	UN3	UN2	UN1	UN0	OV3	OV2	OV1	OV0
		IE			TM					UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0

OV*n* **Interrupt by overflow bit (*n*: 0 ~ 3)**

0 Disable

1 Enable

UN*n* **Interrupt by underflow bit (*n*: 0 ~ 3)**

0 Disable

1 Enable

IX*n* **Interrupt by index status bit (*n*: 0 ~ 3)**

0 Disable

1 Enable

DI*n* **Interrupt by digital input bit (*n*: 0 ~ 3)**

0 Disable

1 Enable

OC*n* **Interrupt by counter over compare bit (*n*: 0 ~ 3)**

0 Disable

1 Enable

UC*n* **Interrupt by counter under compare bit (*n*: 0 ~ 3)**

0 Disable

1 Enable

TM **Interrupt by timer pulse bit**

0 Disable

1 Enable

IE **Overall interrupt enable bit**

0 Disable

1 Enable

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C.7 Interrupt status register — BASE+20H

Table C-6 PCI-1784 Register for interrupt status

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
20H	R	Interrupt status															
		DI3	DI2	DI1	DI0	IX3	IX2	IX1	IX0	UN3	UN2	UN1	UN0	OV3	OV2	OV1	OV0
		IF			TM					UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0

OV*n* **Counter overflow interrupt flag (*n*: 0 ~ 3)**

0 Disable

1 Enable

UN*n* **Counter underflow interrupt flag (*n*: 0 ~ 3)**

0 Disable

1 Enable

IX*n* **Index input interrupt flag (*n*: 0 ~ 3)**

0 Disable

1 Enable

DI*n* **Digital input interrupt flag (*n*: 0 ~ 3)**

0 Disable

1 Enable

OC*n* **Counter over compare interrupt by flag (*n*: 0 ~ 3)**

0 Disable

1 Enable

UC*n* **Counter under compare interrupt flag (*n*: 0 ~ 3)**

0 Disable

1 Enable

TM **Timer pulse interrupt flag**

0 Disable

1 Enable

IF **Overall interrupt enable flag**

0 Disable

1 Enable

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C.8 Clear Interrupt — BASE+24H

Table C-7 PCI-1784 Register for clock control

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
24H	W	Clock Control															
																SC1	SC0
							TB2	TB1	TB0	DV7	DV6	DV5	DV4	DV3	DV2	DV1	DV0

SC1 ~ SC0 **Sampling clock select**

00 8 MHz sampling clock

01 4 MHz sampling clock

10 2 MHz sampling clock

11 1 MHz sampling clock

DV7 ~ DV0 **Timer divider control**

TB2 ~ TB0 **Timer time base select**

000 50 KHz time base

001 5 KHz time base

010 500 Hz time base

011 50 Hz time base

100 5 Hz time base

101 N/A

110 N/A

111 N/A

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C.9 Clear Interrupt — BASE+24H

Read this register to clear the interrupt.

Table C-8 PCI-1784 Register for clear interrupt

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
24H	R	**Clear Interrupt**															

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C.10 Software latch — BASE+28H

Table C-9 PCI-1784 Register for software latch

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
28H	W	Software Latch															
														SL3	SL2	SL1	SL0

SL*n* **Software latch command (*n*: 0 ~ 3)**

0 N/A

1 Latch counter to latch register

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C.11 Board ID — BASE+28H

The PCI-1784 offers Board ID register BASE+28H. With correct Board ID settings, user can easily identify and access each card during hardware configuration and software programming.

Table C-10 PCI-1784 Board ID data

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
28H	R	Board ID															
		0	0	0	0	0	0	0	0	0	0	0	0	BD3	BD2	BD1	BD0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BD3 ~ DB0 **Board ID**

BD0 LSB of the Board ID

BD3 MSB of the Board ID

BD3	BD2	BD1	BD0	Board ID
1	1	1	1	15
1	1	1	0	14
1	1	0	1	13
1	1	0	0	12
1	0	1	1	11
1	0	1	0	10
1	0	0	1	9
1	0	0	0	8
0	1	1	1	7
0	1	1	0	6
0	1	0	1	5
0	1	0	0	4
0	0	1	1	3
0	0	1	0	2
0	0	0	1	1
0	0	0	0	0

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C.12 Reset counter — BASE+2CH

Table C-11 PCI-1784 Register for reset counter

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
2CH	W	Reset Counter															
														SR3	SR2	SR1	SR0

SR*n* **Reset counter command (*n*: 0 ~ 3)**

0 N/A

1 Reset counter to default value

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C.13 Digital output — BASE+30H

Table C-12 PCI-1784 Register for digital output

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
30H	W	Digital Output															
														DO3	DO2	DO1	DO0
		DM3	DM2	DM1	DM0	LE3	LE2	LE1	LE0	UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0

DO3 ~ DO0 **Digital output data**

OC*n* **Digital output by over compare register (*n*: 0 ~ 3)**

UC*n* **Digital output by under compare register (*n*: 0 ~ 3)**

LE*n* **Digital output level control (*n*: 0 ~ 3)**

0 Pulse with counter clock

1 Level with clear interrupt

DM*n* **Digital output mode control (*n*: 0 ~ 3)**

0 Normal

1 Indicated

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C.14 Digital input/output — BASE+30H

Table C-13 PCI-1784 Register for digital input/output

Base Addr.		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
30H	R	Digital Input/Output															
										DI3	DI2	DI1	DI0	DO3	DO2	DO1	DO0
		DM3	DM2	DM1	DM0	LE3	LE2	LE1	LE0	UC3	UC2	UC1	UC0	OC3	OC2	OC1	OC0

DO3 ~ DO0 **Digital output data**

DI3 ~ DI0 **Digital input data**

OC*n* **Digital output by over compare register (*n*: 0 ~ 3)**

UC*n* **Digital output by under compare register (*n*: 0 ~ 3)**

LE*n* **Digital output level control (*n*: 0 ~ 3)**

0 Pulse with counter clock

1 Level with clear interrupt

DM*n* **Digital output mode control (*n*: 0 ~ 3)**

0 Normal

1 Indicated

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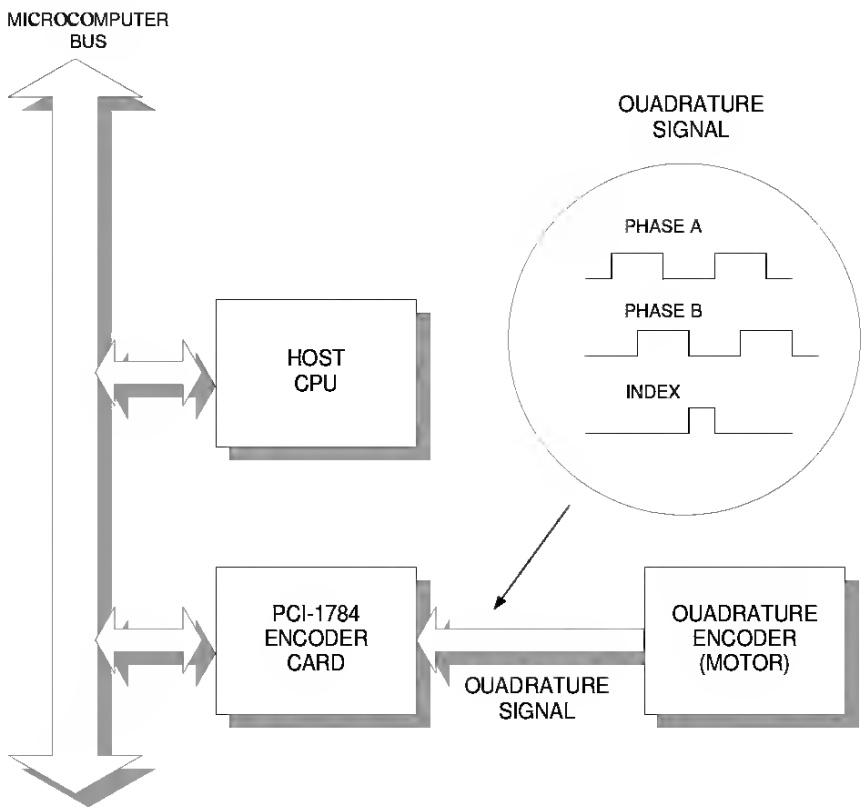
Appendix D. Operation

D.1 Quadrature encoder introduction

In typical closed-loop control systems, also know as servo system, the encoder interface senses motor position and sends a position signal to the controller. The diagram below shows a typical servo system.

The encoder generates pulses which indicate the shaft position. The encoder output includes two signals, commonly called channel A and channel B, which generate N pulses revolution. The two signals are shifted by a quarter of a cycle, as shown below. The shift between the two signals enables the controller to determine the direction of rotation, depending on whether channel A leads channel B or vice versa.



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Single-ended vs. differential input

Most encoders produce square wave signals with TTL levels. Industrial systems often use encoder with differential signals, i.e. channel A and B and their complements. Differential signals can reduce sensitivity to noise and allow longer transmission distances. Encoders may also produce a third signal once per revolution know as the index or marker. The encoder interface can use the index signal to reset the counter, allowing you to monitor the position within the current revolution.

D.2 Counter modes

The following table shows the maximum input rate for each input mode and system clock rate. Values are given for each system clock frequency.

Mode	Maximum input rate			
	8MHz	4MHz	2MHz	1MHz
Quadrature x1, x2, x4	2 MHz	1 MHz	500 KHz	250 KHz
2-pulse	8 MHz	4 MHz	2 MHz	1 MHz
Pulse/direction	8 MHz	4 MHz	2 MHz	1 MHz

Counter modes are as follows:

Quadrature input counter mode

Quadrature input consists of two square wave inputs (A and B)which are 90° out of phase. The PCI-1784 counts square wave transitions and determines the direction by comparing whether channel A is leading channel B or vice versa.

There are three different counting methods in quadrature input mode:

x1 The counter will increment (or decrement) the counter whenever a rising edge occurs on input channel A.

x2 The counter will increment (or decrement) whenever a rising or falling edge occurs on input channel A.

x4 The counter will increment (or decrement) whenever a rising or falling edge occurs on input channel A or B.

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2-pulse mode

In 2-pulse mode the PCI-1784 uses two input pulses as counting sources: one for clockwise (CW) and one for counterclockwise (CCW) counting. The counter will increment whenever a rising edge occurs on channel A. It will decrement whenever a rising edge occurs on channel B.

pulse/direction mode

In pulse/direction mode the PCI-1784 uses one input line (A) for pulse input and one line (B) for direction. If channel B is high (1), the counter will decrement whenever a rising edge occurs in channel A. If channel B is low (0), the counter will increment whenever a rising edge occurs on channel A.

Disabled mode

PCI-1784 will not accept input, but you can access all its registers.

You select the mode by programming the card's registers: BASE+00H for CH0, BASE+04H for CH1, BASE+08H for CH2 and BASE+0CH for CH3. See Appendix C for more information.

D.3 Digital noise filter

Noise immunity is the most important requirement for reliable encoder interface operation. The PCI-1784 conditions the input signal with a four stage digital filter. This filter reduces glitches (digital noise) or spikes by sampling by sampling the input at 1, 2, 4 or 8MHz. The filter output waveforms change only when an input has the same value for four consecutive sampling edges. The filter thus rejects noise or pulses shorter than four sampling clock periods. You can optimize noise immunity by selecting the lowest sampling frequency that compatible with the highest input rate you expect.

The PCI-1784 accepts up to 2 MHz quadrature frequency at 8 MHz filter sampling speed. At 2 MHz sampling speed it can still accept up

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to 500 KHz quadrature input frequency.

A 3600 rpm motor with 2000 ppr encoder will nave a maximum quadrature frequency of 3600×2000÷60＝120 KHz. In the above example the 2 MHz sampling clock will have the noise immunity and will meet the required input frequency.

The following table shows the maximum noise pulse width that the filter will reject for each system clock frequency:

Clock frequency	Maximum width
8 MHz	0.5 usec.
4 MHz	1 usec.
2 MHz	2 usec.
1 MHz	4 usec.

D.4 Latch mode

When you read a counter, you are actually reading a value latched into a buffer. The PCI-1784 provides seven different latching modes, only one of which is active at any given time. Make sure that you know which latching mode is current whenever you read the counter. Otherwise, you may read an old value or one that was latched at a different time than you expect. You select the latching mode for each channel individually.

The PCI-1784's latching modes are as follows:

S/W latch

Whenever you read a channel's data registers, the counter values will be latched in buffer. Please refer to page 41 (BASE+28H) for detail information.

Index latch

A rising edge on the channel's index input line will latch the channel's counter value.

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DI0 latch

A rising edge on the board's DI0 line will latch the counter value for the channel.

DI1 latch

A rising edge on the DI1 line will latch the counter value for the channel.

DI2 latch

A rising edge on the board's DI2 line will latch the counter value for the channel.

DI3 latch

A rising edge on the DI3 line will latch the counter value for the channel.

Timer latch

The card latches the counter value on a rising edge of pulses from the card's on-board timer.

D.5 Counter reset value

Bit 4 (RF) of registers BASE+00H, 04H, 08H and 0CH control the initial (reset) value of for each counter. You can select either 00000000 or 80000000 (hex). When the counter is reset, it will take this value.

When RF＝0, the counter will reset to 80000000h.
When RF＝1, the counter will reset to 00000000h.

D.6 Timer function

The card can generate an interrupt to the system based on a signal from its digital inputs, overflow/underflow and over-compare / under-compare of its counters, or on a programmed time interval. It can repeatedly generate interrupts at any time interval you specify, from 20 microseconds to 51 second. These interrupts let you precisely monitor the speed of a control system.

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D.7 Interrupt function

The PCI-1784 can generate an interrupt to the PC for any of the following conditions:

1. Counter 0 overflow
2. Counter 1 overflow
3. Counter 2 overflow
4. Counter 3 overflow
5. Counter 0 underflow
6. Counter 1 underflow
7. Counter 2 underflow
8. Counter 3 underflow
9. Counter 0 index in
10. Counter 1 index in
11. Counter 2 index in
12. Counter 3 index in
13. DI0 input
14. DI1 input
15. DI2 input
16. DI3 input
17. Counter 0 over-compare
18. Counter 1 over-compare
19. Counter 2 over-compare
20. Counter 3 over-compare
21. Counter 0 under-compare
22. Counter 1 under-compare
23. Counter 2 under-compare
24. Counter 3 under-compare
25. Timer pulse

Note that you can use only one of the card's interrupt sources at a given time, unless you specially program your interrupt service routine to handle multiple interrupt sources.

You enable the PCI-1784 interrupt functions by accessed through the

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registers at BASE+20H. You will need to set the chip's interrupt mask register to exclude all but one of the interrupt lines.

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